CLEAN: What techniques for washing fresh produce are associated with favorable food safety outcomes?

Conclusion

A limited body of evidence has shown that washing vegetables and fruit by running water over them at home or under laboratory simulation conditions is associated with reduced produce microbial loads.

Grade

Limited

Evidence Summary Overview

A total of three studies were reviewed regarding in-home techniques for washing fresh produce that are associated with favorable food safety outcomes such as reduced subsequent risk of home-based foodborne illnesses. All three studies (two non-randomized trials and one cross-sectional study) received neutral quality ratings.

Washing fresh produce at home is the last opportunity that consumers have to reduce potential pathogen loads in these foods before consuming them and is likely to help reduce food safety risks (Dharod et al, 2007b; Kilonzo-Nthenge et al, 2006; Parnell et al, 2005). Dharod et al, (2007b) demonstrated a significant reduction in total microbial and coliform counts associated with washing lettuce and tomato under running water in Puerto Rican households' home kitchens during preparation of a "chicken and salad" meal. Parnell et al, (2005) concluded that scrubbing melons with a clean brush under running water for 60 seconds is effective for Salmonella removal in the home setting. Kilonzo-Nthenge et al, (2006) also showed that washing produce under cold running tap water with rubbing and brushing, where applicable, has a potential to reduce surface bacterial contamination. Thus, providing consumer with information as to how to properly sanitize brushes should be a priority.

Evidence Summary Paragraphs

Kilonzo-Nthenge et al, 2006 (neutral quality), a non-randomized trial conducted in the US, determined the efficacy of different cleaning methods in reducing bacterial contamination on fresh produce in a home setting. Lettuce, broccoli, apples and tomatoes were inoculated with Listeria innocua and then subjected to combinations of the following cleaning procedures: (i) soak for two minutes in tap water, Veggie Wash solution, 5% vinegar solution, or 13% lemon solution and (ii) rinse under running tap water, rinse and rub under running tap water, brush under running tap water or wipe with wet/dry paper towel. The study found that pre-soaking in water before rinsing significantly reduced bacteria in apples, tomatoes and lettuce, but not in broccoli; wiping apples and tomatoes with wet or dry paper towel showed lower bacterial reductions compared with soaking and rinsing procedures; blossom ends of apples and flower sections of broccoli were more contaminated than the apple surface or broccoli stem, respectively, after soaking and rinsing; reductions of L. innocua in both tomatoes and apples (2.01 to 2.89 log CFU/g) were more than in lettuce and broccoli (1.41 to 1.88 log CFU/g) when subjected to same washing procedures; reductions of surface contamination of lettuce after soaking in lemon or vinegar solutions were not significantly different ($P>0.05$) from lettuce soaking in cold tap water. Results from this study suggest that washing produce under cold running tap water with rubbing and brushing, where applicable, has a potential to reduce surface bacterial contamination.

Parnell et al, 2005 (neutral quality), a non-randomized trial conducted in the US, evaluated the

efficacy of washing methods on the reduction of Salmonella on cantaloupes and honeydew melons that were collected directly from production fields in the Central Valley of California during peak production periods between August and September. Different numbers of melon samples were used in different experiments; melons were washed by immersion in 1,500ml of water or 200ppm total chlorine and allowed to soak or were scrubbed over the entire melon surface with a sterile vegetable brush for 60 seconds. Salmonella typhimurium was reduced on the rind of cantaloupe by 1.8 log CFU/melon after soaking for 60 seconds in 200ppm total chlorine, which was significantly better than the 0.7 log CFU/melon achieved with soaking in water, and scrubbing with a vegetable brush was shown to be significantly more effective (0.9 log CFU/melon) than soaking alone. Reductions of 2.8 log CFU/melon were observed when honeydew melons were soaked in water, and when scrubbed in water, the reductions increased to over 4.6 log CFU/melon.

Dharod et al, 2007b (neutral quality), a cross-sectional study, applied the Hazard Analysis Critical Control Point (HACCP) model at the household level to identify sanitation and food handling "Critical Control Points" for home prepared "Chicken and Salad" using direct observations and microbiological indicators. A sample of 60 Puerto Rican women recruited in inner city Hartford, Connecticut, were provided chicken breasts (CB), lettuce and tomatoes (LT), and spices to prepare a meal in their home kitchens; food and kitchen surface samples were collected during stages of food preparation and tested for total and coliform counts, and presence of pathogenic microrganisms; observed food handling behaviors were compared with microbial testing results. The following behaviors were observed: Of those who used the same cutting board to cut CB and LT, only 55% washed the cutting board with soap and water in between use and 13% of households used the same knife for cutting CB and LT without washing it in between. Total bacterial and coliform counts of LT were significantly higher for unwashed LT (whole or after cutting) than for washed samples. There was a significant positive correlation in coliform count between: Cutting board sample after its use and LT sample collected after handling (cutting or washing (if done)) (r=0.416, P=0.020).

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Author, Year, Study Design, Class, Rating	Population/Sample Description and Location	Design/Variables	Results/Behavioral Outcomes/Significance	Limitations
Dharod et al, 2007b Study Design: Cross-sectional study Class: D Rating:	N=60 Puerto Rican women, main meal preparers of the household recruited from inner city Hartford, Connecticut. Mean age: 40 years. More than half (N=36) spoke only Spanish at home. Half (N=33) had less than a high school education. Half (N=33) had monthly income of ≤$1,000. Most (N=51) were unemployed.	Design: Subjects were provided chicken breasts, lettuce, tomatoes and spices to prepare a meal in their home kitchens. Food and kitchen surface samples were collected during stages of food preparation and tested for total and coliform counts, and presence of Listeria, Campylobacter, Salmonella	The following behaviors were observed: Of those who used same cutting board to cut CB and LT, only 55% washed cutting board with soap and water in between use and 13% of households used same knife for cutting CB and LT without washing it in between. Total bacterial and coliform counts of LT significantly ↑ for unwashed LT (whole or after cutting) than for washed samples. Significant positive	None.

		genus and S. aureus. Observed food handling behaviors were compared with microbial testing results and used to identify critical control points during the meal preparation.	correlation in coliform count between: Cutting board sample after its use and LT sample collected after handling (cutting or washing (if done)) (r=0.416, P=0.020).	
Kilonzo-Nthenge A. Chen FC et al, 2006 Study Design: Non-randomized trial. Class: C Rating: 	Samples of lettuce, tomatoes, apples and broccoli were purchased from local grocery store in Nashville, Tennessee, on the day before experiment and stored in their original boxes at 40°C. Location: United States.	Dependent variable: Listeria innocua (ATCC, 33090) (used as a surrogate for L. monocytogenes). Independent variables: Cleaning procedures and materials used in soaking and rinsing. Type of produce (lettuce, broccoli, apples, tomato). Parts of fruits and vegetables (stem and blossom of apples, flower and stem of broccoli). Inoculated recovery method (stomacher for lettuce and broccoli; bacteria detached from surface by hand rubbing for two minutes in peptone water for apple and tomatoes).	Pre-soaking in water before rinsing significantly ↓ bacteria in apples, tomatoes and lettuce, but not in broccoli. Wiping apples and tomatoes with wet or dry paper towel showed lower bacterial ↓ compared with soaking and rinsing procedures. Blossom ends of apples and flower sections of broccoli were more contaminated than apple surface or broccoli stem, respectively, after soaking and rinsing. ↓ of L. innocua in both tomatoes and apples (2.01 to 2.89 log CFU/g) were more than in lettuce and broccoli (1.41 to 1.88 log CFU/g) when subjected to same washing procedures. Reductions of surface contamination of lettuce after soaking in lemon or vinegar solutions were not significantly different (P>0.05) from lettuce soaking in cold tap water.	Small sample size. Limitations per authors: Model system used designed to evaluate the effectiveness of cleaning methods after a short period of surface contamination on fresh produce. Different fruit and vegetable surfaces and coating materials applied during processing might have affected the degree of attachment of bacteria, and how easily bacteria were washed off during cleaning procedures.

Parnell TL, Harris LJ et al, 2005 Study Design: Non-randomized trial Class: C Rating:	Melons collected directly from production fields in the Central Valley of California during peak production periods between August and September. Different numbers of melon samples used in different experiments. Location: United States	Efficacy of washing methods on the ↓ of Salmonella on cantaloupes and honeydew melons was evaluated. Melons washed by immersion in 1,500ml of water or 200ppm total chlorine and allowed to soak or were scrubbed over entire melon surface with a sterile vegetable brush for 60 seconds.	Salmonella typhimurium was ↓ on rind of cantaloupe by 1.8 log CFU per melon after soaking for 60 seconds in 200ppm total chlorine, which was significantly better than 0.7 log CFU per melon achieved with soaking in water. Scrubbing with vegetable brush shown to be significantly more effective (0.9 log CFU per melon) than soaking alone. ↓ of 2.8 log CFU per melon observed when honeydew melons were soaked in water, and when scrubbed in water, the reductions ↑ to over 4.6 log CFU per melon.	Small number of melon and cantaloupe samples.

Research Design and Implementation
For a summary of the Research Design and Implementation results, click here.

Worksheets

Dharod JM, Pérez-Escamilla R, Paciello S, Venkitanarayanan K, Bermúdez-Millán A, Damio G. Critical Control Points for Home Prepared 'Chicken and Salad' in Puerto Rican Households. Food Protection Trends 2007; 27: 544-552.

Kilonzo-Nthenge A, Chen FC, Godwin SL. Efficacy of home washing methods in controlling surface microbial contamination on fresh produce. J Food Prot. 2006 Feb; 69(2): 330-334.

Parnell TL, Harris LJ, Suslow TV. Reducing Salmonella on cantaloupes and honeydew melons using wash practices applicable to post-harvest handling, food service and consumer preparation. Int J Food Microbiol. 2005 Mar 1; 99 (1): 59-70.